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METHOD FOR MANUFACTURING METALLIC TITANIUM BY ELECTRICAL DISCHARGE

Brief Description of the Drawings

The attached figure shows one example of the working of the method of the present invention, and is a longitudinal sectional view.

Detailed Description of the Invention

The present invention relates to a method for obtaining metallic titanium from titanium tetrachloride by an electrical discharge, which is characterized by the fact that titanium tetrachloride and hydrogen are caused to jet from one pole, and a discharge is caused to take place between this pole and the other pole, thus decomposing the titanium tetrachloride so that metallic titanium is produced. The object of the present invention is to provide a method for producing metallic titanium more economically and by means of an easier operation than in conventional methods, such as substitution methods using metallic magnesium.

The present invention is a method for obtaining metallic titanium by subjecting titanium tetrachloride to an electrical discharge; in this method, titanium tetrachloride and hydrogen are caused to jet from one pole, and a discharge is caused to take place between this pole and the other pole, thus decomposing the titanium tetrachloride so that metallic titanium is produced.

Conventionally, the manufacture of titanium tetrachloride by treating rutile, titanium iron ore or titanium dioxide, etc., with chlorine gas has been industrialized and widely used. Recently, furthermore, methods for producing metallic titanium from the titanium tetrachloride thus obtained have been particularly studied, and various methods have been proposed. A method that is currently being practiced industrially is a method in which titanium tetrachloride and metallic magnesium are reacted in a high-temperature inert gas, so that metallic titanium is produced by the following reaction:

$$TiCl_4 + 2Mg = Ti + 2MgCl_2$$

However, such a method requires that high-purity metallic magnesium be used at the rate of 1.1 to 1.5 times the amount of metallic titanium; furthermore, the apparatus is complicated, and an intermittent operation is ordinarily unavoidable. Various studies are being conducted in order to solve such problems; however, the method of the present invention eliminates the drawbacks of such conventional problems, and offers an extremely novel method for the manufacture of metallic titanium.

Specifically, noting that metallic titanium can be produced according to the following formula by reacting titanium chloride with hydrogen at a high temperature of 2000°C or higher, the present inventor conducted various studies, and perfected the present invention.

$$TiCl_4 + 2H_2 = Ti + 4HCl$$

However, it is extremely difficult to obtain metallic titanium on an industrial scale using such a reaction. If an attempt is made to perform this reaction merely by heating [the reactants] in a high-temperature furnace, it is almost impossible to obtain a sufficient reaction, so that it is naturally not easy to obtain metallic titanium on an industrial scale. In the method of the present invention, on the other hand, titanium tetrachloride and hydrogen are caused to jet from a nozzle into a hydrogen gas [atmosphere], and a current is passed through this [reaction mixture] so that one pole is formed. Another receiving pole is disposed in the bottom portion of the furnace relative to this [first pole], and an electrical discharge is caused to take place between the two poles so that the mixed gas is heated to a temperature of 2000°C or higher; as a result, the titanium tetrachloride and hydrogen readily react. The metallic titanium [that is produced by this reaction] is separated out; meanwhile, the hydrochloric acid and unreacted titanium tetrachloride are conducted elsewhere and appropriately treated. In this way, metallic titanium can be produced continuously by means of a relatively simple apparatus and method.

Initially, when hydrogen alone is caused to jet into the hydrogen gas [atmosphere] from a jet hole, and a discharge is caused to take place between [this pole] and the receiving pole, a dark purple discharge is generated. However, when hydrogen gas mixed with titanium tetrachloride gas is passed through the system, the discharge abruptly changes to a discharge with a white color, thus clearly indicating that a reaction is taking place. If the conditions of the discharge current and discharge distance are [appropriately] satisfied, the heating temperature of the gas can be sufficiently elevated so that this temperature reaches 2000°C, thus making it possible to manufacture the desired metallic titanium.

The [attached] figure shows one example of the working of the method of the present invention. Here, a nozzle 1 is provided which has a jet tube 3 that jets a mixed gas consisting of titanium tetrachloride gas and hydrogen gas into a furnace 4. A hydrogen gas feeding tube 2 is disposed outside the jet tube 3 inside the nozzle 1, and the receiving pole 5 is set at the pole that receives the gas that is caused to jet from the nozzle 1. With the jet nozzle 1 used as one pole and the receiving pole 5 used as the other pole, these poles are connected to a power supply, and when an appropriate voltage is applied, an arc discharge is generated through the mixed gas, so that the mixed gas is heated, and metallic titanium is produced. This system has a structure in which the hydrogen chloride gas produced by the reaction and the excess hydrogen are conducted elsewhere by a discharge pipe 6 and treated.

Thus, it is certain that the present invention provides a method which can be worked by means of a relatively simple apparatus, and which has an industrial value not seen in conventional methods.

In order to show one example of the working of the method of the present invention, $TiCl_4 + H_2$ was blown into [a reaction vessel] from a tungsten pole 1 with an internal diameter of 5 mm, and a discharge was caused to take place between this pole and a counter-pole with the total amount of H_2 set at approximately 50% in excess of the stoichiometric amount. The various conditions in this case were as follows:

Distance between electrodes	15 mm
Transformer connection	Series
Secondary voltage	3720 V
Secondary current	533 mA
Amount of $TiCl_4 + H_2$	approximately 4 L/min
Gas pressure	320 mm H_2O

A discharged was continuously performed under these conditions. As a result, a branch-form powdered crystal accumulated in the vicinity of the lower electrode. When this product was analyzed, it was found that the product consisting of 89% metallic titanium, with the remainder consisting of lower chlorides. When this product was heated in a vacuum, metallic titanium with [a purity of] 99.4% was obtained.

Claims

A method for manufacturing metallic titanium from titanium tetrachloride by means of an electric discharge, in which a mixed gas consisting of titanium tetrachloride gas and hydrogen is caused to jet [into a reaction vessel] from one pole, and an electrical discharge is caused to take place between this pole and a receiving pole for this [pole], so that metallic titanium is formed, as is described in detail in the main text in accordance with the object described in the main text.